CLAIMS

1. A data receiving device for receiving packet data through a transmission path and outputting the packet data in accordance with time information added beforehand to the packet data, the data receiving device comprising:

a storage means for storing the received packet data; and

a control means for separating the time information added to the received packet data and reading the packet data from the storage means in accordance with the separated time information;

wherein when the control means generates a read timing, the control means calculates a clock frequency deviation between a data sending device and the data receiving device in accordance with an integration result of an amount of the received packet data temporarily stored in the storage means and a measurement result of the integration time, and adds an offset amount based on the deviation to the read timing of the received packet data, thereby generating the read timing of the received packet data.

2. The data receiving device according to claim 1,

wherein the data receiving device receives a plurality of packet data sent from a plurality of data sending devices,

the storage means includes a plurality of storage areas for storing the plurality of packet data received by the receiving means respectively, and

the control means generates a plurality of read timings corresponding to the plurality of storage areas.

3. The data receiving device according to claim 1,

wherein when the control means calculates the clock frequency deviation between the data sending device and the data receiving device and generates the read timing of the received packet data, the control means

calculates a target value by dividing the integration result of the amount of the received packet data written in the storage means in a predetermined period from a beginning of receiving of the packet data, by an average receiving rate of the received packet data in an integration time,

calculates a measurement value by dividing the integration result of the amount of the received packet data written in the storage means after the predetermined period, by the average receiving rate of the received packet data in the integration time, and

sets a difference between the target value and the measurement value as the clock frequency deviation.

4. The data receiving device according to claim 1,

wherein when the control means calculates the clock frequency deviation between the data sending device and the data receiving device and generates the read timing of the received packet data, the control means

calculates a target value by dividing the integration result of the amount of the received packet data written in the storage means in a predetermined period from a beginning of receiving of the packet data, by an integration time,

calculates a measurement value by dividing the integration result of the amount of the received packet data written in the storage means after the predetermined period, by the integration time, and

sets a difference between the target value and the measurement value as the clock frequency deviation.

5. The data receiving device according to claim 4, wherein the control means calculates an average receiving rate of the packet data received by the receiving means, and if the calculated average receiving rate changes by a predetermined value or greater, the control means recalculates and sets the target value.

6. The data receiving device according to claim 1, further comprising:

a second storage means for storing a previous offset amount calculated from the clock frequency deviation between the data sending device and the data receiving device when previous receiving of the packet data finishes and device identification information specific to the data sending device when the previous offset amount is calculated;

wherein if the data sending device which transmits new packet data is the data sending device having the device identification information stored in the second storage means when receiving of the new packet data starts, the control means generates the read timing, with an initial value set as the offset amount stored in the second storage means.

7. The data receiving device according to claim 6, wherein the device identification information identifying the data sending device is at least one of an IP address and a MAC address of the data sending device.

8. The data receiving device according to claim 1, wherein the control means includes:

a time information separation means for separating the time information added to the received packet data;

a data read timing generation means for reading packet data from the storage means in accordance with the time information separated by the time information separation means; and

an integral calculation means for calculating a normalized integral of the amount of the received packet temporarily stored in the storage means, in accordance with the integration result of the amount of the received packet temporarily stored in the storage means, the number of the processed packets, and the integration measurement time;

wherein when the data read timing generation means generates a read timing of the received packet, the data read timing generation means subtracts the normalized integral of the received packet calculated by the integral calculation means when the previous clock frequency deviation is calculated from the normalized integral of the received packet output from the integral calculation means, calculates a clock frequency deviation between the data sending device and the data receiving device, on the basis of the result of subtraction, and adds an offset on the basis of the calculated clock frequency deviation to the read timing of the received packet, thereby generating the read timing of the received packet.

9. The data receiving device according to claim 8, further comprising:

a clock frequency deviation convergence determination means for determining that the clock frequency deviation between the data sending device and the data receiving device has converged if an absolute value of the calculated clock frequency deviation does not exceed a predetermined level for a predetermined number of times and continuously when the clock frequency deviation

is calculated.

10. The data receiving device according to claim 9, wherein when a determination whether the clock frequency deviation between the data sending device and the data receiving device has converged is made by the clock frequency deviation convergence determination means, the determination of convergence is made with a plurality of conditions changed in stages at least.

11. The data receiving device according to claim 10, wherein when the determination of convergence is made, at least one of the measurement time of the integral of the received packet, a gain used when an offset is added to the read timing of the received packet in accordance with the calculated clock frequency deviation, and a predetermined value used to determine the convergence is changed in each of the stages.

12. The data receiving device according to claim 9, further comprising:

a low-frequency component extraction means for extracting a low-frequency component of an offset value added to the read timing of the received packet in accordance with the calculated clock frequency deviation;

wherein when the clock frequency deviation convergence determination means determines whether the clock frequency deviation has converged, if an amplitude of an output of the low-frequency component extraction means enters a predetermined range for a predetermined number of times continuously, the clock frequency deviation convergence determination means determines that the clock frequency deviation between the data sending device and the data receiving device has converged.

13. The data receiving device according to claim 8, wherein when an offset value is added to the read timing of the received packet in accordance with the calculated clock frequency deviation, if an offset value is beyond a predetermined range obtained from a frequency precision of a clock generation means used in the data sending device and the data receiving device, an amplitude of the offset value is limited so that the offset value is kept in a predetermined range.

14. The data receiving device according to claim 8, wherein when the clock frequency deviation convergence determination means determines that the clock frequency has converged, an offset is forced to be added to the read timing of the received packet so that a normalized integral of the amount of the received packet temporarily stored in the storage means is brought into a predetermined range

15. The data receiving device according to claim 14, wherein the calculation of the clock frequency deviation between the data sending device and the data receiving device, which is performed immediately after an offset is forced to be added to the read timing of the received packet so that the normalized integral of the amount of the received packet temporarily stored in the storage means is brought into the predetermined range, is masked.

16. The data receiving device according to claim 8, wherein when the read timing of the received packet is generated by adding an offset to the read timing of the received packet in accordance with the calculated clock

frequency deviation, if the number of the processed packets varies greatly in comparison with a value measured at the last time, determination that the receiving rate of the received packet has varied greatly is made, and a calculation of the clock frequency deviation between the data sending device and the data receiving device is masked.

17. The data receiving device according to claim 8, further comprising:

an input packet count counting means for counting the number of the packets input to the storage means when the read timing of the received packet is generated by adding the offset to the read timing of the received packet in accordance with the calculated clock frequency deviation;

wherein the receiving rate of the received packet is determined to have varied greatly when the number of the input packets output from the input packet count counting means change greatly in comparison with the previously measured input packet count, and a calculation of the clock frequency deviation between the data sending device and the data receiving device is masked.

18. The data receiving device according to claim 8,

wherein when the read timing of the received packet is generated by adding an offset to the read timing of the received packet in accordance with the calculated clock frequency deviation, if the result of subtracting the normalized integral of the received packet calculated by the integral calculation means exceeds a predetermined range, determination that the receiving rate of the received packet has varied greatly is made, and the calculation of the clock frequency deviation between the

data sending device and the data receiving device is masked.

19. The data receiving device according to claim 8,

wherein when the offset value added to the read timing of the received packet is calculated in accordance with the calculated clock frequency deviation, if the storage means overflows or underflows while the integration result of the amount of the received packet temporarily stored in the storage means, the number of the processed packets, and the integration measurement time are measured, the calculation of a clock frequency deviation between the data sending device and the data receiving device is masked.

20. A data receiving method for receiving packet data through a transmission path and outputting packet data in accordance time information added beforehand to the received packet data, the method comprising the steps of:

storing the received packet data temporarily in a storage means; and

separating the time information added to the received packet data and reading the packet data from the storage means in accordance with the separated time information;

wherein when a read timing of the received packet data is generated in the step of reading the packet data, a clock frequency deviation between a data sending device and a data receiving device is calculated in accordance with an integration result of an amount of the received packet data temporarily stored in the storage means and a measurement result of the integration time, and an offset amount based on the deviation is added to the read timing of the received packet data, thereby generating the read

timing of the received packet data.

21. The data receiving method according to claim 20,

wherein when a clock frequency deviation between the data sending device and the data receiving device is calculated and the read timing of the received packet data is generated,

a target value is calculated by dividing the integration result of the amount of the received packet data written in the storage means in a predetermined period from a beginning of receiving of the packet data, by the average receiving rate of the received packet data in the integration time,

a measurement value is calculated by dividing the integration result of the amount of the received packet data written in the storage means after the predetermined period, by the average receiving rate of the received packet data in the integration time, and

a difference between the target value and the measurement value is set as the clock frequency deviation.

22. The data receiving method according to claim 20,

wherein when a clock frequency deviation between the data sending device and the data receiving device is calculated and the read timing of the received packet data is generated,

a target value is calculated by dividing the integration result of the amount of the received packet data written in the storage means in a predetermined period from a beginning of receiving of the packet data in an integration time,

a measurement value is calculated by dividing the integration result of the amount of the received packet data written in the storage means after the predetermined

period in the integration time, and

a difference between the target value and the measurement value is set as the clock frequency deviation.

23. The data receiving method according to claim 22,

wherein an average receiving rate of the received packet data is calculated, and if the calculated average receiving rate changes by a predetermined value or greater, the target value is recalculated and set.

24. The data receiving method according to claim 20, further comprising the step of:

storing a previous offset amount calculated from the clock frequency deviation between the data sending device and the data receiving device when previous receiving of the packet data finishes and device identification information specific to the data sending device in the previous offset amount calculation in a second storage means when the receiving of the previous packet data finishes;

wherein when the receiving of the new packet data starts, if the data sending device sending new packet data is the data sending device having the device identification information stored in the second storage means, the read timing is generated, with the offset amount stored in the second storage means set as the initial value.

25. A data receiving method for receiving packet data through a transmission path and outputting the packet data in accordance with time information added beforehand to the packet data, the method comprising:

a storage step of storing the received packet data in a storage means;

a time information separation step of separating the time information added to the received packet data,

a read timing generation step of setting a data read timing for reading the packet data from the storage means, in accordance with the time information separated by the time information separation step;

an integration step of integrating the amount of the received packet temporarily stored in the storage step;

an integration time measurement step of measuring an integration time in the integration step and the number of the processed packets;

an integral calculation step of calculating a normalized integral of the amount of the received packet temporarily stored in the storage step, in accordance with the integration result obtained in the integration step and the integration time and the number of the processed packets measured in the integration time measurement step; and

a clock frequency deviation calculation step of calculating a clock frequency deviation between the data sending device and the data receiving device, in accordance with a result of subtracting the normalized integral of the received packet calculated in the integral calculation step in the calculation of the previous clock frequency deviation, from the normalized integral of the received packet calculated in the integral calculation step;

wherein an offset is added to the read timing in accordance with the clock frequency deviation information calculated in the clock frequency deviation calculation step when a read timing is generated in the read timing generation step.

26. The data receiving method according to claim 25,

further comprising:

a clock frequency deviation convergence determination step of determining that the clock frequency deviation between the data sending device and the data receiving device has converged if an absolute value of the calculated clock frequency deviation does not exceed a predetermined level for a predetermined number of times continuously when the clock frequency deviation is calculated.

27. The data receiving method according to claim 26,

wherein when a determination whether a clock frequency deviation between the data sending device and the data receiving device has converged is made in the clock frequency deviation convergence determination step, the determination of convergence is made with a plurality of conditions changed in stages at least.

28. The data receiving method according to claim 27,

wherein when the determination of convergence is made, at least one of the measurement time of the integral of the received packet, a gain used when an offset is added to the read timing of the received packet in accordance with the calculated clock frequency deviation, and a predetermined value used to determine the convergence is changed in each of stages

29. The data receiving method according to claim 26, further comprising:

a low-frequency component extraction step of extracting a low-frequency component of an offset value added to the read timing of the received packet in accordance with the calculated clock frequency deviation;

wherein when the determination whether the clock

frequency deviation has converged, if an amplitude of an output of the low-frequency component extraction means enters a predetermined range for a predetermined number of times continuously, determination that the clock frequency deviation between the data sending device and the data receiving device has converged is made.

30. The data receiving method according to claim 25, wherein when an offset is added to the read timing of the received packet in accordance with the calculated clock frequency deviation, an amplitude is limited so that an offset value is kept in a predetermined range if the offset value is beyond a predetermined range obtained from a frequency precision of a clock generation means used in the data sending device and the data receiving device.

31. The data receiving method according to claim 26, wherein when in the clock frequency deviation convergence determination step, determination that the clock frequency has converged is made, an offset is forced to be added to the read timing of the received packet so that the normalized integral of the amount of the received packet temporarily stored in the storage means is brought into a predetermined range

32. The data receiving method according to claim 31, wherein the calculation of the clock frequency deviation between the data sending device and the data receiving device, which is performed immediately after an offset is forced to be added to the read timing of the received packet so that the normalized integral of the amount of the received packet temporarily stored in the storage means is brought into a predetermined range, is masked.

33. The data receiving method according to claim 25, wherein when the read timing of the received packet is generated by adding an offset to the read timing of the received packet in accordance with the calculated clock frequency deviation, if the number of the processed packets varies greatly in comparison with a value measured at the last time, determination that the receiving rate of the received packet has varied greatly is made, and the calculation of the clock frequency deviation between the data sending device and the data receiving device is masked.

34. The data receiving method according to claim 25, further comprising:

an input packet count counting step of counting the number of the packets input to the storage means when the read timing of the received packet is generated by adding the offset to the read timing of the received packet in accordance with the calculated clock frequency deviation;

wherein the receiving rate of the received packet is determined to have varied greatly when the number of the input packets output in the input packet count counting step change greatly in comparison with the previously measured input packet count, and the calculation of a clock frequency deviation between the data sending device and the data receiving device is masked.

35. The data receiving method according to claim 25, wherein when the read timing of the received packet is generated by adding an offset to the read timing of the received packet in accordance with the calculated clock frequency deviation, if the result of subtracting the normalized integral of the received packet calculated in

the integral calculation step exceeds a predetermined range, determination that the receiving rate of the received packet has varied greatly is made, and the calculation of the clock frequency deviation between the data sending device and the data receiving device is masked.

36. The data receiving method according to claim 25, wherein when an offset value added to the read timing of the received packet is calculated in accordance with the calculated clock frequency deviation, if the storage means overflows or underflows while the integration result of the amount of the received packet temporarily stored in the storage step, the number of the processed packets, and the integration measurement time are measured, the calculation of the clock frequency deviation between the data sending device and the data receiving device is masked.